Online-Journals.org

iJOE International Journal of Online and Biomedical Engineering

iJOE | eISSN: 2626-8493 | Vol. 22 No. 5 (2026) | OPEN ACCESS

https://doi.org/10.3991/ijoe.v22i05.60619

PAPER

Educational Innovation in Nursing through MIT App Inventor: Experience in the Development of Prototypes of Mobile Applications in Health

Nereyda Hernández Nava[1], Rosa Eréndira Fosado Quiroz[1], Ma. del Rocío Rocha Rodríguez[2], Alejandro Martínez Ramírez[1] (✉)

[1]Universidad Autónoma de San Luis Potosí, Matehuala, SLP, Mexico

[2]Universidad Autónoma de San Luis Potosí, Río Verde, SLP, Mexico

alejandro.martinez@uaslp.mx

ABSTRACT

The digital transformation of health systems and the expansion of nursing roles require the development of competencies in designing mobile tools aligned with training standards. The objective of this work is to describe the experience of educational innovation in nursing through the use of MIT App Inventor for the design and development of prototypes of mobile applications in health, aimed at the evaluation of the risk of sleep apnea, caregiver burden, and perceived quality of life. A descriptive, cross-sectional study (June–November 2025) was conducted in two phases: a 20-hour project-based learning workshop with 10 students and a pilot implementation to assess prototype functionality through direct observation. Five applications were developed based on the STOP-Bang, Zarit, and WHOQOL-BREF instruments, all of which demonstrated stable performance and results consistent with traditional analysis. The findings suggest that MIT App Inventor is a viable didactic resource for transforming validated instruments into functional applications. Further research is recommended to evaluate usability and psychometric equivalence and to formally integrate digital health and app development into nursing curricula.

KEYWORDS

nursing, educational innovation, MIT app inventor, mHealth, mobile applications, STOP-Bang, Zarit's scale, WHOQOL-BREF, interinstitutional commission for the training of human resources for health (CIFRHS)

1 INTRODUCTION

In recent years, nursing has experienced an accelerated expansion of its practice scenarios and its clinical, educational, and community responsibilities. This growth occurs in parallel with the digital transformation of health systems: the near-universal availability of smartphones and the rise of mobile health and telemedicine

Hernández Nava, N., Fosado Quiroz, R. E., Rocha Rodríguez, M. D. R., Martínez Ramírez, A. (2026). Educational Innovation in Nursing through MIT App Inventor: Experience in the Development of Prototypes of Mobile Applications in Health. *International Journal of Online and Biomedical Engineering (iJOE)*, 22(5), pp. 22–39. https://doi.org/10.3991/ijoe.v22i05.60619

Article submitted 2026-01-17. Revision uploaded 2026-02-11. Final acceptance 2026-02-13.

have opened up concrete opportunities to design tools to support decision-making, therapeutic education, patient monitoring, and care management. In this context, the creation of mobile applications aimed at nursing is not only a technological trend but also a response to real care needs, especially in environments where the care load, the geographical dispersion of users, or the continuity of treatment pose persistent challenges.

However, developing an effective nursing app involves much more than programming functions. It requires starting from well-defined clinical or training problems, working with a user-centered approach (patients, caregivers, or professionals), and ensuring that the content and processes of the tool are relevant, safe, and aligned with professional competencies.

This is where the national regulatory-academic framework becomes relevant: in Mexico, the Interinstitutional Commission for the Training of Human Resources for Health (CIFRHS) defines essential criteria to evaluate study plans and programs of careers in the health area, including the bachelor's degree in nursing. These criteria allow for an objective assessment of curricular coherence, competency-based approach, academic quality, clinical fields, infrastructure, and evaluation mechanisms, among other key components [1]. Within this system, the CIFRHS Academic Technical Opinion (OTA) functions as an institutional indicator of quality: it is granted through the application of the guide of essential criteria and its checklist, which integrates multiple items to determine the relevance and solidity of a training program [1].

Bringing this indicator into the conversation about apps in nursing is key for two reasons. First, because it reinforces that any educational or clinical innovation must be based on quality standards already established for professional training. Second, because when designing digital tools for nursing students or staff, it is possible and desirable to map their contents, flows, and expected results to the CIFRHS/OTA criteria; that is, to ensure that the app favors real clinical competencies, valid learning methods, and evaluation consistent with recognized graduation profiles.

Under this logic, this paper describes the process of creating five mobile applications developed by ten nursing students, conceived as technological extensions of the nursing process and as support resources for competency-based training, with a focus on research.

Together, the applications integrate standardized instruments with evidence of validity, relevant to the assessment of key dimensions in care and health: (1) The Zarit Burden Interview (ZBI), used to estimate the perceived burden and caregiver burden, particularly in caregivers of people with chronic diseases, disability, or dementia [2]; (2) the STOP-Bang questionnaire, a clinical screening instrument aimed at estimating the probability of obstructive sleep apnea (OSA) and supporting the indication of confirmatory studies, such as polysomnography, without constituting a diagnostic method in itself [3]; and (3) the WHOQOL-BREF, a measure developed by the World Health Organization to assess perceived quality of life in domains of well-being and daily functioning, incorporating the sociocultural and personal context of the individual [4].

In terms of distribution, two applications were designed for the assessment of caregiver burden using the Zarit Scale, two focused on screening the risk of OSA using STOP-BANG, and one was aimed at assessing quality of life through the WHOQOL-BREF. The development of these tools was based on needs identified during academic work, particularly related to the observation and systematic recording of signs and symptoms related to sleep, as well as to the caregiver's well-being [2], [3], [4].

The project was developed through an iterative design approach using MIT App Inventor [5], with the participation of students of the Bachelor's Degree in Nursing of

the Multidisciplinary Academic Unit Altiplano Region of the Autonomous University of San Luis Potosí, located in Matehuala, San Luis Potosí, Mexico. The work was organized in successive cycles that included the identification of requirements, the selection and configuration of components (interface, storage, and navigation), the design of screens, and the construction of the logic through block programming, followed by functional tests and adjustments of the prototype. In this way, rather than emphasizing clinical aspects, the paper highlights the ability of students to transform disciplinary content into an operational digital tool, strengthening technological, methodological, and research competencies within their professional training.

The objective of this work is to describe the experience of educational innovation in Nursing through the use of MIT App Inventor for the design and development of prototypes of mobile applications in health, aimed at the evaluation of the risk of sleep apnea, caregiver burden, and perceived quality of life.

1.1 Literature review

In the reviewed scientific production, a first line of work focused on the use of digital applications as a strategy to support care and strengthen the professional role of nursing is distinguished. In general terms, these solutions are oriented towards three converging purposes: (a) to accompany caregivers of people with chronic conditions, (b) to improve communication between services, patients, and families, and (c) to optimize care processes, especially those related to clinical documentation and continuity of care. Overall, this literature suggests that mobile and web technology can contribute to reducing operational and emotional burdens, facilitating decision-making, and improving care coordination, although with heterogeneous and context-dependent results.

A relevant reference in the field of support for caregivers is the review by Ramírez-Perdomo, Valenzuela-Mazabel, and Torres-Flórez [6], who analyzed publications between 2016 and 2023 and identified 11 studies on mobile applications and web platforms aimed at caregivers of people with chronic non-communicable diseases. The tools described are grouped into three axes: strengthening networks and social support, reducing stress and caregiver burden through self-guided interventions (mindfulness or cognitive-behavioral therapy), and responding to specific needs with personalized information and resources. Although the authors acknowledge that there are still few digital solutions focused directly on caregivers, they highlight that those available show potential to improve their well-being, care skills, and decision-making and pose as a priority challenge the design and evaluation of new applications with the active participation of nursing.

In a complementary line, the work of Simón Miguélez and Sufrate Sorzano [7] synthesizes evidence on how nurses and students use applications in practice and training. Based on a literature review in PubMed, SciELO, Google Scholar, and BVS (period 2018–2024), the authors report that nurses mainly use apps for immediate clinical consultation and pharmacological support, in addition to tools such as dose calculators, procedure guides, and resources for quick access to evidence. In the field of training, they point to an increase in the use of apps after the pandemic, aimed at reinforcing theoretical content, learning pharmacology, and academic coordination. However, they note a high diversity of applications and low coincidence between studies regarding which are the most used, which reflects a dynamic field that requires more specific research and more systematic educational strategies for its integration.

Communication with families and patient support networks appears as another nucleus of interest. In this regard, the pilot study by Challinor et al. [8] evaluated Brenna, a mobile and web application designed to streamline communication between nurses and family/friends of residents in residential care facilities for the elderly, under a family-centered care approach. Using online surveys and open-ended feedback, the authors found that family and friends perceived a moderate improvement in communicative clarity; however, they identified critical limitations associated with the inconsistency of some updates, redundancy with other channels, and, above all, the lack of bidirectionality. Trust and satisfaction tended to be at levels close to neutrality. In contrast, the staff valued the tool in a highly positive way, highlighting time savings, stress reduction, and the value of the written record of the communication. These findings suggest that the usefulness of communication apps depends not only on their design, but also on their implementation, the quality of the information entered, and the possibility of maintaining reciprocal exchanges with families.

Finally, in the component of optimization of care processes, Ehrler et al. [9] describe the development and testing of a mobile application for nursing that allows documenting and consulting clinical information with the patient with access to components of the electronic medical record (EHR). The purpose was to reduce problems associated with the use of paper and transcription (errors, outdatedness, and duplication of work), favoring more timely documentation. The authors report an iterative process based on the software development life cycle (SDLC), with stages of requirements, prototypes, validations, and progressive testing (laboratory, room, and pilot). A cross-cutting contribution of the study is the relevance of early and sustained nursing participation and coordination with computer security teams to balance usability and data protection, a key condition for acceptance in real scenarios.

This type of literary production shows that digital applications can add value to nursing care and work when they respond to specific needs (support for caregivers, effective communication, and clinical documentation), incorporate usability criteria, and are implemented with training and process alignment. At the same time, a persistent gap is observed between the potential of these tools and their performance in practice, especially when communication is one-way, information is inconsistent, or adoption is made without clear organizational strategies. Consequently, the literature points to the need for more user-centered designs, assessments in real contexts, and nursing participation throughout the lifecycle of digital solutions.

A second block of the literature focuses on mobile educational applications designed to strengthen training and the development of nursing competencies, both in students and in practicing professionals. In this set, Apps are conceived as ubiquitous learning tools that combine simulation (virtual or scenario-based), multimedia resources, guides, and structured content and that, at different levels, are associated with favorable results such as improvements in learning, increased motivation, greater self-efficacy, and strengthening of clinical and professional skills. Even so, the evidence also emphasizes that the impact depends on the pedagogical design, usability, adequacy to the clinical context, and degree of evaluation in real conditions.

Along these lines, González Acevedo et al. [10] provide an overview from a systematic review of the incorporation of digital tools in the training of nursing students, particularly driven by the context of the COVID-19 pandemic. Based on a PubMed search guided by PICO and a PRISMA process, the authors selected 14 studies (2017–2021) and synthesized that technologies such as virtual simulation, digital patients, online courses, and learning platforms strengthen training in four dimensions: (1) understanding the role and making clinical decisions with

greater confidence, (2) development of socio-emotional skills such as communication and empathy, (3) promotion of critical and reflective thinking, and (4) stimulation of autonomy and continuous learning. Taken together, the central argument is that these resources raise performance and offer safe environments to practice without exposing them to real risks.

In a complementary way, the narrative review by Armour et al. [11] focuses specifically on mobile educational APPS designed for nurses, midwives, and students, emphasizing which design elements favor learning and motivation. Through a systematic search in four databases and a thematic analysis of 16 studies, the authors organize their findings into four cores: (1) design elements (multimedia and virtual simulation stand out), (2) motivational factors (especially usability/utility and gamification), (3) effects on practice (reported improvements in knowledge, self-efficacy, psychomotor skills, and competencies such as communication and leadership), and (4) considerations for development (user adaptation, content quality, evaluation with end users, and, where possible, co-design). Their conclusion is consistent: well-designed educational apps can complement traditional clinical training, but research is still required to optimize their design in specific clinical contexts and strengthen evidence in real scenarios.

At the level of development and test studies, Nowicki et al. [12] describe the design, construction, and pre-assessment of DiagNurse, an educational app for Android aimed at supporting clinical assessment through standardized scales and questionnaires. The project followed the ADDIE model (analysis, design, development, implementation, and evaluation), integrating review of previous apps, needs analysis with teachers/students/nurses, and selection of instruments. The app was implemented in APK format and included features such as assessment tools, a patient list, and an A–Z guide, with an emphasis on privacy through local storage. Usability was evaluated in the laboratory with 20 participants by eye-tracking, qualitative evaluation, and quantitative measurement, obtaining high scores in the SUS (83.3 ± 8.9 in students and 84 ± 12.7 in nurses), suggesting a positive and potential experience to facilitate the learning and execution of clinical assessment.

Finally, the study by Lu et al. [13] broadens the landscape towards mHealth apps in the student population by designing an application for nursing students that integrates physical measurements with IoT-connected devices and generates personalized health recommendations. In a cross-sectional study with 283 surveys (2020–2023), they report good acceptance and moderately high usability (~3.6–3.7/5). Although the focus is student self-care, the work is relevant to this axis because it reinforces the idea that apps can support health habits and self-regulated learning; at the same time, it highlights areas for improvement (greater personalization, mental health, and longitudinal evaluation) and generalization limitations due to context and sample composition.

Overall, this second group shows that mobile educational applications have positioned themselves as a relevant pedagogical resource for the training of students and the strengthening of competencies in practicing nurses. The available evidence suggests that, when integrated with resources such as virtual simulation, multimedia, and clinical guidelines, these tools can improve learning, motivation, self-efficacy, and, in some cases, the performance of clinical and professional skills. However, the findings also warn that its effectiveness depends on user-centered designs with high usability, relevance of content, and a pedagogical architecture that avoids cognitive burden. Therefore, the need to expand evaluations in real scenarios and with longitudinal follow-up, as well as to optimize the design for specific clinical contexts through validation with end users and, when possible, co-design processes, is insisted upon.

Finally, a third group of publications focuses on the role of nursing in the design and engineering of mHealth applications, that is, on how clinical knowledge is integrated into the software life cycle to produce safe, useful, and coherent digital solutions with care. Along these lines, the literature agrees that nursing participation should not be limited to validating finished products: it is proposed to incorporate it from early stages to translate real needs of the healthcare environment into functional requirements, safety criteria, workflows, and quality standards.

In this direction, the scoping review by Bakker et al. [14], based on 157 studies (2016–2023), shows that nurses appear in multiple phases of development but with a greater presence in design/prototypes, requirements surveys, and testing and little intervention in strategic planning and technical development. The dominant role is that of clinical experts and evaluators, with limited participation as informaticians, researchers, or explicit patient advocates. In addition, they report that many apps remain in the prototype phase, tend to focus on informing, instructing, or collecting data, and have inconsistent use of standards, which reinforces the recommendation to integrate nursing in a broader and more sustained way to improve safety, usability, and alignment with care practice.

In addition, Niemiec and Cota [15] provide an engineering perspective by proposing a component-based development framework to reduce costs and complexity in mHealth. Their central argument is that no-code platforms facilitate rapid construction, but they do not adequately solve clinical requirements and can force health professionals to operate with technical concepts foreign to their language. To close this gap, they propose to represent common behaviors and interventions as reusable components, derived from the NANDA–NIC–NOC taxonomy, so that care plans can be translated into software modules. This lays the foundation for customizable, patient-centric applications aligned with clinical workflows, with less reliance on advanced technical skills.

This group argues that strengthening the role of nursing in technological development (from requirements to clinical validation and functional design) and translating disciplinary language into software structures are two complementary ways to move towards more implementable, interoperable, and clinically relevant mHealth [14], [15].

Among the works on Apps created, a study stands out that, in the presence of burnout in nursing (≈17% at a high level in its sample), proposes a preventive mobile application as a practical and low-cost response. The APP was developed with MIT App Inventor (Scratch-like logic) to facilitate a fast, accessible, and replicable prototype without complex infrastructure. Its design is organized into three modules: Training (training and awareness), Assessment (screening with the CBI and risk classification), and Support (recommendations and referral according to results). Overall, the proposal positions the PPP as a bridge between the detection of the problem and preventive action, although it is suggested to validate its effectiveness with larger samples and in real use [16].

In the same order, we find the work of Barbosa de Lira et al. [17], which describe the development and evaluation of a mobile application prototype (“Care for the elderly”) aimed at caregivers of the elderly, with the purpose of offering quick evidence-based guides for frequent care problems. The prototype was designed for Android, with a didactic approach (simple language and images), and was implemented with C# and the Xamarin framework, also highlighting that access to the content does not require the internet or database, which favors availability in everyday contexts. Functionally, the app organizes 76 topics into seven axes: vaccination, food, hygiene, fall prevention, pressure injury prevention, medication use, and a first aid module (e.g., PCR, choking, seizures, hypoglycemia, intoxication, and stroke).

The quality of the software was evaluated using engineering attributes (functionality, usability, reliability, efficiency, maintainability, and portability) by an interdisciplinary nursing and IT committee, obtaining an overall average of 4.6/5, considered sufficient to advance to validation; the main technical limitation was portability due to its initial implementation only on Android, suggesting multiplatform adaptation and validation with users in real practice.

The work carried out by Gómez-Álvarez [18], entitled Communicator for patients, describes an Android application aimed at conscious patients who cannot communicate verbally (for example, due to intubation, aphasia, or being bedridden). Its purpose is to facilitate the expression of basic needs by health personnel or caregivers. The application was developed with MIT App Inventor 2, so it is presented as a free, low-cost, and adaptable alternative, usable on mobile phones or tablets without requiring additional hardware. It has two modes of communication: (1) a system of icons or pictograms that, when selected, activates a voice synthesizer to emit messages such as "I am thirsty" or "could you accompany me"; and (2) a free text option, in which the patient types a message and the app reads it aloud, allowing for more specific requests. The paper also mentions a feedback channel to propose improvements and notes that the app is available on Google Play.

2 METHODOLOGY

A descriptive and cross-sectional study was carried out, with an applied approach and quantitative methodology, framed as an educational innovation experience with nursing students. The study was oriented to the design, development, and functional evaluation of prototypes of mobile applications in health for the Android operating system, developed through MIT App Inventor as digital tools for the structured capture of information in academic activities and research projects.

The work was carried out between June and November 2025 and included two phases: (1) a training and construction phase, focused on competency-based training and prototype development; and (2) a pilot implementation phase, aimed at exploring its performance and usefulness in an academic, controlled, and supervised environment, without distribution of applications or clinical implementation with patients or end users.

Phase 1. Prototype formation and development. This phase was carried out in the academic context of the Bachelor's Degree in Nursing of the Autonomous University of San Luis Potosí, Multidisciplinary Academic Unit Altiplano Region, in Matehuala, San Luis Potosí, Mexico. 10 intentionally selected students participated, were enrolled in the Summer of Science 2025 program, and aimed at induction to research at the Autonomous University of San Luis Potosí. A 20-hour workshop course focused on the development of basic visual programming competencies using MIT App Inventor, using a project-based learning strategy. As a final product, the group designed a functional prototype of a mobile application that integrated a) screen structure and navigation, b) forms for data capture, c) basic field validation, and d) information storage mechanisms. The App was built using App Inventor's proprietary model: component design and logic programming using blocks, allowing for rapid iterations of testing and improvement.

Phase 2. The second phase consisted of a pilot implementation aimed at the functional evaluation of the prototypes in an operational environment, with institutional authorization documented by official letter No. Dir.270/2025. In this stage, the applications were used for the digital application of the instruments integrated in each

prototype through non-probabilistic sampling for convenience. The sample size (n) varied between prototypes depending on the topic addressed by the students and the availability of participants. The purpose of the real-population implementation was to observe the operational performance of the applications during their continuous use, particularly in terms of navigation, structured response capture, data storage/recording, and generation of results according to the logic of the instrument. Prior to its application, each prototype was reviewed and approved by the teaching team responsible for the course, verifying the correspondence between the digital content and the reference instruments, as well as the basic functionality of the interface. The students operated the applications after receiving specific training on screen flow, response logging procedures, and handling incidents during capture in order to standardize the deployment process and reduce operational errors.

App evaluation criteria. The central axis of the study was the evaluation of the functionality of the prototype during its use in the field. The indicators considered were: a) correct functioning of screens and forms (viewing, capturing, and saving), b) operational stability during the application of the questionnaire, c) continuity of the navigation flow and error handling, and d) behavior under variable connectivity conditions. The functionality was assessed by direct observation of the app's performance during the capture process.

Ethical considerations in the evaluation of the App. Participation were voluntary through informed acceptance. No sensitive data or personal identifiers were recorded; The information was handled confidentially and was used exclusively for academic and research purposes. The study was authorized by the institution and adhered to the applicable guidelines for research on human beings in accordance with the Official Mexican Standard NOM-012-SSA3-2012, which establishes the criteria for the execution of research projects for health in human beings [19].

Analysis of experience. The analysis was based on the review of the performance of the prototype and the documentation of the training and development process. The feasibility of MIT App Inventor as a platform for students to design functional mobile applications aimed at data capture was examined, highlighting its potential as a didactic resource to strengthen digital and methodological skills linked to research projects.

3 RESULTS

3.1 Implementation of the course workshop and prototype development

A 20-hour course-workshop was designed and implemented with the aim of developing mobile applications for educational purposes and health support. Ten students participated in the course and, as a final outcome, developed five functional mobile application prototypes. The prototypes were classified into three application categories according to the health issue addressed: (1) sleep apnea risk detection (two prototypes), (2) caregiver burden assessment (two prototypes), and (3) quality of life assessment (one prototype).

These applications were conceived as operational and educational prototypes. Their primary objective was to demonstrate technical feasibility, student learning outcomes, and the appropriate digitalization of validated clinical instruments (STOP-Bang, Zarit Scale, and WHOQOL-BREF), rather than to function as formally validated digital tools for clinical assessment.

3.2 Prototypes for sleep apnea risk detection

The two prototypes developed within this category focused on the digitalization of the STOP-Bang questionnaire, integrating clinical variables (snoring, daytime sleepiness, sleep quality, and witnessed apnea) and anthropometric measures (weight, neck, waist, and hip circumference). Both applications enabled self-assessment, risk classification (low, moderate, or high), and historical data storage, thereby facilitating longitudinal monitoring (see Figures 1 and 2).

The prototypes were applied to a sample of 98 beneficiaries from a public hospital healthcare system in City Matehuala, San Luis Potosí, México (53 women, 54.1%; 45 men, 45.9%). Descriptive results indicated that 61.2% of participants reported snoring to some degree, while 25.5% were unaware of whether they snored and 13.3% denied the symptom. This finding suggests potential underreporting and highlights the need for systematic identification strategies. Snoring was predominantly observed among individuals with overweight or obesity, with a more pronounced trend in men. Regarding comorbidities, snoring was more frequent among participants with diabetes (28.6%), followed by those without reported chronic disease (17.3%) and those with hypertension (9.2%). Overall, 31% of participants reported a prior diagnosis of arterial hypertension. Daytime fatigue or sleepiness was highly prevalent, with 63% of participants reporting its occurrence at least once per week. Among men, 71% presented a neck circumference ≥43 cm, an anthropometric indicator associated with increased risk of obstructive sleep apnea.

In both prototypes, the risk classification generated by the applications was consistent with results obtained through traditional analysis using Excel spreadsheets, demonstrating functional consistency and correct logical implementation of the instrument. However, no claim of formal psychometric equivalence was intended. The primary difference between the two prototypes lay in the design and presentation of the application interface.

3.3 Prototypes for caregiver burden assessment

Two mobile application (see Figures 3 and 4) prototypes based on the ZBI were developed using MIT App Inventor to support the early detection of burden in informal caregivers. The main application, ZaritCare, integrates a brief five-item self-assessment for educational and awareness purposes, providing an initial estimation of caregiver burden and general self-care recommendations. The applications were conceived as operational and educational prototypes, without the intention of replacing formal clinical assessment or establishing psychometric equivalence.

An exploratory assessment involving caregivers of patients with Alzheimer's disease (n = 5) and terminal cancer (n = 7) revealed a consistent inverse relationship between caregiver burden and quality of life, with greater impairment in the physical and psychological domains among caregivers with higher burden scores. Caregiver burden was influenced not only by the patient's condition but also by contextual factors such as caregiving time, disease progression, and availability of support networks. In the terminal cancer group, most caregivers presented low burden levels, although a subgroup at moderate risk was identified, indicating the need for preventive interventions.

Fig. 1. Sleep Apnea App a) Home screen b) STOP-Bang questionnaire screen c) Block diagram with App Inventor of the application's programming

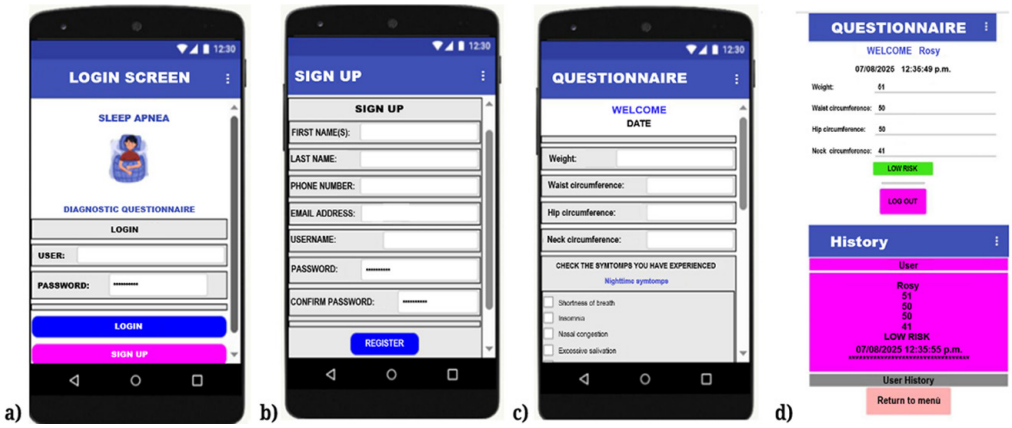

Fig. 2. Prototype 2 of an application for sleep apnea: a) Log-in screen; b) Sign-up screen; c) Questionnaire screen; d) Results screen

The applications enabled structured response recording, automatic burden calculation, and risk classification (low, moderate, high). Caregivers reported high acceptance and perceived usefulness, particularly due to the applications' simplicity and accessibility. Overall, the findings highlight the relevance of early burden detection and demonstrate the technical feasibility and educational value of integrating validated clinical scales into mobile applications as support tools in digital health education.

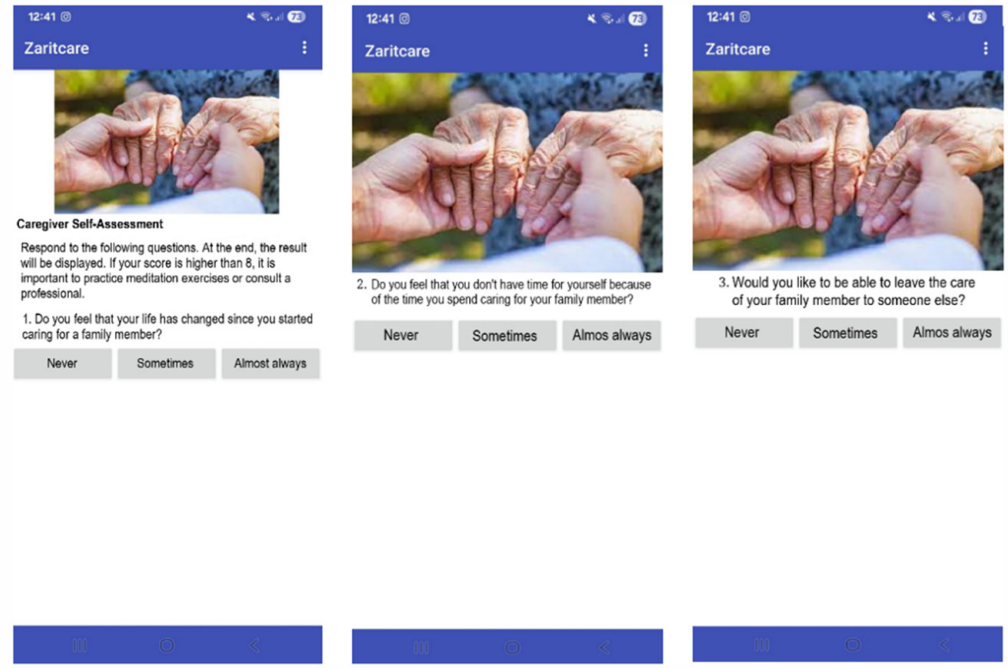

Fig. 3. Three sample questions from the Zarit App questionnaire

Fig. 4. Application that uses the Zarit scale to assess caregiver burden: a) Login screen; b) Questionnaire screen; c) Results screen; d) History screen

3.4 Prototype for quality of life assessment

A mobile application prototype was developed for quality-of-life assessment based on the WHOQOL-BREF instrument. The application allows response capture, automatic score calculation, and immediate visualization of results, serving educational purposes and supporting self-assessment (see Figure 5).

Results derived from a structured interview conducted with informal caregivers receiving care within a public clinical–hospital setting (n = 7) enabled the description of their sociodemographic characteristics and perceived quality of life. Regarding age, the highest proportion of participants was concentrated in the 41–45-year range, followed by the 51–55-year group, whereas the 18–20 and 71–75-year ranges were less represented. In terms of sex, a clear predominance of females was observed (86%), with males accounting for 14%, a pattern consistent with reports in the literature on informal caregiving roles. With respect to quality of life, most caregivers reported a fair level of quality of life (71.4%), while 28.6% indicated low quality of life. These findings suggest the presence of areas amenable to intervention, particularly in contexts involving prolonged caregiving.

When comparing results obtained through the mobile application with data collected via traditional structured interviews, a high level of concordance was observed in quality-of-life classification. This supports the functional consistency of the digital prototype and the correct logical implementation of the WHOQOL-BREF instrument, without implying formal psychometric validation.

Fig. 5. Application to measure quality of life according to the WHOQOL-BREF scale: a) Log-in screen; b) Sign-up screen; c) Menu screen; d) and e) Questionnaire; f) Result of the questionnaire; g) User history

3.5 Results of the training process

The training process demonstrated students' ability to translate well-established clinical instruments into functional digital environments by integrating clinical variables, scoring rules, and classification criteria into operational mobile applications. Throughout the course workshop, participants showed a solid understanding of the functioning of clinically used scales and their correct logical implementation in digital formats, while preserving the structure and intent of the original instruments.

In the developed applications, the instruments were applied in parallel using both traditional formats and mobile applications. A high level of concordance in result classification was observed between the two methods. This concordance was reflected in the agreement of risk levels, degrees of caregiver burden, and quality-of-life categories, confirming that the applications consistently reproduced the calculation procedures and categorization criteria of the original instruments.

The results also indicate that students successfully designed applications oriented toward real-world nursing practice scenarios, particularly in contexts of prevention, self-assessment, and support for early detection in non-clinical settings. The integration of features such as response recording, automatic score calculation, and immediate result visualization reflects the development of foundational competencies in digital health and mobile technologies applied to healthcare.

Regarding the scope of the generated products, the applications correspond to functional prototypes developed for educational and exploratory purposes. At this stage of the project, evaluation focused on technical feasibility and functional consistency, without including formal usability testing, reliability assessment, or psychometric validation. Consequently, the prototypes are not intended as clinical diagnostic tools but rather as resources to support learning and health awareness. Formal validation is identified as a future line of work.

4 DISCUSSION

The results of this study support the idea that nursing students without previous programming training can develop functional prototypes of mobile applications using low/no-code tools such as MIT App Inventor, which coincides with evidence that highlights the usefulness of visual environments to facilitate the development of digital solutions by non-IT personnel [5], [16]. This trend of democratization of technological development is aligned with recent work on citizen development, which indicates that low/no-code platforms reduce barriers to entry and accelerate the translation of disciplinary knowledge into functional artifacts [20]. This leads to a prospective view in which it becomes necessary to incorporate the use of multiplatform solutions and applications oriented toward the integration of digital tools capable of supporting the resolution of clinical challenges [21], [22], [23].

Likewise, the congruence observed between traditional measurements and digital versions of instruments such as the Zarit Scale and WHOQOL-BREF is consistent with reviews that have reported equivalence between electronic and paper formats when adaptation is made with methodological care [24], [25]. This body of evidence suggests that, under controlled conditions, mobile versions have the potential to offer data comparable to classical methods, although it is recommended that future phases incorporate formal evaluation of psychometric equivalence and usability [26].

The literature on health technology adoption also highlights that the acceptance of applications by users depends on factors such as the perception of usefulness, ease of use, and contextual support [27], [28]. Initial acceptance data among caregivers and students are consistent with these findings and indicate that real-needs-oriented design facilitates adoption, although it is recognized that assessment in real-world settings and with larger samples is a key step in confirming these effects in clinical contexts.

In this broader adoption context, the increasing use of digital technologies in health has promoted the development of mobile applications conceived as support tools for traditional evaluation and monitoring processes. Rather than replacing conventional methods, these solutions aim to complement them, facilitating their implementation in everyday settings and contributing to the efficiency of care without altering established methodological quality criteria [29].

In methodological terms, it has been pointed out that the implementation of digital interventions without a systematic evaluation of user experience can limit their effectiveness and impact [30]. This reinforces the need for the development of future iterations of these applications to be accompanied by standardized usability studies and longitudinal tests that consider contextual factors, barriers, and facilitators of adoption [26], [30].

In addition, user-centered design approaches have been shown to provide substantial benefits to the relevance and sustainability of mobile health (mHealth) solutions [31]. These principles offer a framework for structuring future co-design phases with end users (students, caregivers, and health professionals), which could enhance the user experience, accessibility, and adherence to the functions proposed in the prototypes. The scope of these functions may range from therapeutic support and clinical data management and visualization to communication and coordination among patients, caregivers, and health professionals [32].

Finally, in relation to screening for conditions such as sleep apnea, the literature supports the usefulness of questionnaires such as STOP-Bang as preliminary guidance tools and not as definitive diagnoses [3]. This adequately contextualizes the findings observed in the developed prototypes and underscores the importance of positioning these applications as training and initial screening support, rather than as substitutes for comprehensive clinical evaluations.

5 CONCLUSIONS

The objective of this study was to describe the experience of educational innovation in Nursing through the use of MIT App Inventor for the design and development of prototypes of mobile applications in health, aimed at assessing the risk of sleep apnea, caregiver burden, and perceived quality of life. From the results obtained, it can be concluded that this objective was satisfactorily achieved, both in the training and functional fields.

Firstly, experience shows that it is feasible to integrate the development of mobile applications as a pedagogical strategy within nursing training, even in students without previous programming training. The use of MIT App Inventor allowed students to transform disciplinary content and standardized clinical instruments into functional digital prototypes, strengthening technological, methodological, and research skills. This approach is consistent with a competency-based training model and with the academic quality criteria established by the CIFRHS, particularly in relation to curricular relevance, the integration of information technologies, and the articulation between theory, practice, and research.

Secondly, the prototypes developed showed adequate functional performance during their pilot implementation, highlighting operational stability, correct structured data capture, and coherence of navigation flows. The congruence observed between the results obtained through the applications and those derived from traditional evaluation methods suggests that these tools can constitute a valid support for academic and research activities, especially in screening, registration, and follow-up contexts, without replacing formal clinical evaluation or established diagnostic processes.

Findings related to the assessment of sleep apnea risk, caregiver burden, and perceived quality of life reflect patterns consistent with the scientific literature. In particular, the usefulness of instruments such as STOP-Bang, the Zarit Scale, and the WHOQOL-BREF when integrated into digital formats is confirmed, as well as the inverse relationship between caregiver burden and quality of life, with special impact on the physical and psychological domains. These results reinforce the relevance of developing brief and accessible digital tools that facilitate the early detection of risks and guide preventive interventions, especially in populations with high demand for care.

From an educational perspective, the active involvement of students in the design and development of the applications favored a deeper understanding of the Nursing process, the standardization of instruments, and the logic of health information systems. This active role positions Nursing not only as a user of technologies but also as a generator and evaluator of digital solutions, in line with the state of the art that underlines the need for early and sustained participation of the discipline in the life cycle of mHealth application development.

In light of these findings and the evidence reviewed, the relevance of formally incorporating a subject oriented to the development of mobile applications and digital health within the curriculum of the Bachelor's Degree in Nursing is highlighted. The state-of-the-art shows that educational and clinical applications designed with nursing participation have greater relevance, usability, and alignment with care, while the CIFRHS criteria emphasize competency-based training, educational innovation, and the integration of technologies as essential components of quality programs. In this sense, a subject of this type would allow the articulation of clinical knowledge, logical thinking, user-centered design, use of no-code platforms, and evaluation of health technologies, strengthening the graduate profile and the OTA of the training programs.

However, important limitations of the study are recognized, including the pilot nature of the implementation, the small sample sizes, and the absence of formal evaluations of usability, user experience, and psychometric equivalence. Therefore, it is recommended that future research expand the validation of these prototypes through standardized usability studies, longitudinal designs, and applications in real clinical scenarios, always in accordance with current ethical regulations.

In conclusion, the experience described confirms that the use of low/no-code platforms such as MIT App Inventor constitutes a viable, relevant, and pedagogically sound strategy to promote educational innovation in Nursing, effectively integrating technology, research, and professional training. Beyond the conceptual proposal, the study demonstrates a practical validation of the approach, as the developed applications functioned correctly and generated clinical scores consistent with established instruments, supporting their functional reliability in educational contexts.

Furthermore, the methodological design grounded in Project-Based Learning and pilot implementation is well aligned with the experience report format, providing a clear and replicable framework for other educational institutions interested

in incorporating mobile health development into nursing curricula. These findings highlight the importance of advancing toward curricula that explicitly integrate digital health competencies and mobile application development, contributing to the preparation of nursing professionals capable of responding to current healthcare system demands and of leading digital transformation processes oriented toward patient care, quality, and safety.

6 REFERENCES

[1] Inter-Institutional Commission for the Training of Human Resources for Health (CIFRHS), "Essential criteria for evaluating curricula and programs in the health area," CIFRHS, 2025. [Online]. Available at: https://cifrhs.salud.gob.mx/site1/planes-programas/criterios_esenciales.html [Accessed: Dec. 24, 2025].

[2] X. Montero Pardo, S. Jurado Cárdenas, A. Valencia Cruz, J. Méndez Venegas, and I. Mora Magaña, "Zarit's caregiver burden scale: Evidence of validity in Mexico," *Psycho-Oncology*, vol. 11, no. 1, pp. 71–85, 2014. https://doi.org/10.5209/rev_PSIC.2014.v11.n1.44918

[3] C. Cruces-Artero *et al.*, "Diagnostic utility of the STOP-Bang questionnaire in moderate sleep apnea in primary care," *Gaceta Sanitaria*, vol. 33, no. 5, pp. 421–426, 2019. https://doi.org/10.1016/j.gaceta.2018.05.003

[4] J. A. López Huerta, R. A. González Romo, and J. M. Tejada Tayabas, "Psychometric properties of the Spanish version of the WHOQOL-BREF quality of life scale in a sample of Mexican adults," *Revista Iberoamericana de Diagnóstico y Evaluación Psicológica (RIDEP)*, vol. 44, no. 2, pp. 105–115, 2017. https://doi.org/10.21865/RIDEP44.2.09

[5] Massachusetts Institute of Technology (MIT), "MIT app inventor," MIT App Inventor, 2025. [Online]. Available at: https://appinventor.mit.edu/ [Accessed: Dec. 24, 2025].

[6] C. A. Ramírez-Perdomo, A. M. Valenzuela-Mazabel, and I. E. Torres-Flórez, "Mobile and web applications oriented toward caregiver support," *Index de Enfermería*, vol. 33, no. 3, p. e14819, 2024. https://doi.org/10.58807/indexenferm20246912

[7] M. Simón Miguélez and T. Sufrate Sorzano, "Mobile applications in nursing: A bibliographic review," Final Degree Project, University of La Rioja, Spain, 2024. [Online]. Available at: https://hdl.handle.net/20.500.14797/677ce82d6640ab1223711dda [Accessed: Nov. 22, 2025].

[8] K. L. Challinor, G. Wright, and A. Burston, "Piloting a communication app for nurses and family/friends in residential aged care," *Collegian*, vol. 32, no. 5, pp. 341–348, 2025. https://doi.org/10.1016/j.colegn.2025.08.003

[9] F. Ehrler, C. Lovis, and K. Blondon, "A mobile phone app for bedside nursing care: Design and development using an adapted software development life cycle model," *JMIR mHealth and uHealth*, vol. 7, no. 4, p. e12551, 2019. https://doi.org/10.2196/12551

[10] C. E. González Acevedo, A. Díaz Oviedo, M. L. Venegas Cepeda, L. Villarruel Hernández, E. García Rosas, and N. Somlander, "Digital tools in nursing education: A systematic review," *Lux Médica*, vol. 18, no. 55, 2023. https://doi.org/10.33064/55lm20234356

[11] T. Armour, E. Coffey, E. Manias, B. Redley, and P. Nicholson, "Development of mobile educational applications designed for nurses: A narrative review," *Nurse Education Today*, vol. 147, p. 106576, 2025. https://doi.org/10.1016/j.nedt.2025.106576

[12] G. J. Nowicki *et al.*, "Development and pre-evaluation of a 'DiagNurse' mobile app to support nurses in clinical diagnosis using the ADDIE model," *Scientific Reports*, vol. 14, p. 29765, 2024. https://doi.org/10.1038/s41598-024-81813-0

[13] A. K.-M. Lu, Y.-L. Chung, Y.-H. Wang, S.-K. Lin, and J.-L. Hsieh, "Developing and evaluating a campus-based health management app for nursing students: A pilot study on usability and user experience," *Digital Health*, vol. 11, pp. 1–12, 2025. https://doi.org/10.1177/20552076251330577

[14] C. J. Bakker *et al.*, "Nurses' roles in mHealth app development: Scoping review," *JMIR Nursing*, vol. 6, p. e46058, 2023. https://doi.org/10.2196/46058

[15] W. Niemiec and É. Cota, "Towards a component-based framework for mHealth apps: Bridging the gap between the nursing domain language and the computation domain," *Journal of Systems and Software*, vol. 230, p. 112497, 2025. https://doi.org/10.1016/j.jss.2025.112497

[16] M. A. Lafraxo, M. Ouadoud, Y. El Madhi, M. Rehali, and A. Soulaymani, "Burnout syndrome prevention measures among nursing staff: Implementing a mobile application based on MIT's App Inventor tool using the Scratch programming," *International Journal of Online Engineering (iJOE)*, vol. 17, no. 4, pp. 81–95, 2021. https://doi.org/10.3991/ijoe.v17i04.20393

[17] T. Barbosa de Lira, F. C. Viana Rocha, C. A. Pinheiro Landim Almeida, F. C. Miranda Amorim, and L. Pazolinni Viana Rocha, "Development and evaluation of an application prototype for caregivers of the elderly," *Global Nursing*, vol. 19, no. 3, pp. 389–421, 2020. https://doi.org/10.6018/eglobal.396671

[18] J. Gómez-Álvarez, "Communicator for patients: An example of gerontological intervention," *International Journal of Research and Technological Innovation*, vol. 6, no. 34, 2018. [Online]. Available at: https://riiit.com.mx/apps/site/files/comunicador-pacientes._jos_g._immx_2017_2_v1.pdf [Accessed: Dec. 24, 2025].

[19] Ministry of Health, "Official Mexican standard NOM-012-SSA3-2012, which establishes the criteria for the execution of research projects for health in human beings," Official Gazette of the Federation, 2013. [Online]. Available at: https://dof.gob.mx/nota_detalle.php?codigo=5284148&fecha=04/01/2013 [Accessed: Dec. 10, 2025].

[20] M. Weber and E. Ziefle, "Exploring acceptance of wearable health devices and fitness apps: A health belief model perspective," *Journal of Biomedical Informatics*, vol. 90, p. 103099, 2019. https://doi.org/10.1016/j.jbi.2019.103099

[21] T. Y. Phan, V. Dang, and V. T. Dang, "An android-based mHealth app for color vision screening and career guidance: Design and validation," *Int. J. Onl. Eng.*, vol. 21, no. 14, pp. 138–155, 2025. https://doi.org/10.3991/ijoe.v21i14.58157

[22] R. Leon-Ayala and L. Andrade-Arenas, "Mobile application design: Caries health care for children," *Int. J. Interact. Mob. Technol.*, vol. 16, no. 21, pp. 183–200, 2022. https://doi.org/10.3991/ijim.v16i21.33967

[23] A. Wali, H. Almagrabi, S. El-Feky, and M. Jokhdar, "Dawwen: An Arabic mental health mobile app based on natural language processing," *Int. J. Interact. Mob. Technol.*, vol. 19, no. 4, pp. 108–131, 2025. https://doi.org/10.3991/ijim.v19i04.51999

[24] D. M. Gwaltney, N. A. Shields, and M. W. Shiffman, "Equivalence of electronic and paper-and-pencil patient-reported outcome measures: A meta-analytic review," *Quality of Life Research*, vol. 23, pp. 667–679, 2014. https://doi.org/10.1007/s11136-014-0637-7

[25] R. M. Santana, M. L. Feeny, and D. J. Brazier, "Measurement equivalence of paper and electronic versions of patient-reported outcome measures: A systematic review and meta-analysis," *Value in Health*, vol. 24, no. 9, pp. 1381–1391, 2021. https://doi.org/10.1016/j.jval.2021.05.005

[26] M. L. Wildenbos, J. Peute, and M. Jaspers, "A framework for evaluating mHealth usability," *International Journal of Medical Informatics*, vol. 114, pp. 66–74, 2018. https://doi.org/10.1016/j.ijmedinf.2018.03.001

[27] C. O'Connor *et al.*, "Understanding factors affecting patient and public engagement and recruitment to digital health interventions: A systematic review of qualitative studies," *BMJ Open*, vol. 9, no. 3, p. e030895, 2019. https://doi.org/10.1136/bmjopen-2019-030895

[28] A. M. Reiners *et al.*, "Factors influencing the implementation success of mHealth interventions in low-resource settings: A systematic review," *BMC Health Services Research*, vol. 21, no. 82, 2021. https://doi.org/10.1186/s12913-021-06195-5

[29] D. Cedeno-Moreno and M. Vargas-Lombardo, "Mobile applications for diabetes self-care and approach to machine learning," *Int. J. Onl. Eng.*, vol. 16, no. 8, pp. 25–38, 2020. https://doi.org/10.3991/ijoe.v16i08.13591

[30] J. E. Lewis and K. A. Wyatt, "Designing and evaluating digital health interventions: Recommendations from the mHealth evidence workshop," *Journal of Medical Internet Research*, vol. 20, no. 12, p. e234, 2018. https://doi.org/10.2196/jmir.9292

[31] A. Albrecht *et al.*, "User-centered design and evaluation of mobile health apps: Lessons from a longitudinal mHealth project," *BMC Medical Informatics and Decision Making*, vol. 20, no. 96, 2020. https://doi.org/10.1186/s12911-020-1105-3

[32] N. Khan, M. I. Qureshi, I. Mustapha, S. Irum, and R. N. Arshad, "A systematic literature review paper on online medical mobile applications in Malaysia," *Int. J. Onl. Eng.*, vol. 16, no. 1, pp. 63–82, 2020. https://doi.org/10.3991/ijoe.v16i01.12263

7 AUTHORS

Nereyda Hernández Nava holds a PhD (2023) in Mental Health from the Instituto Superior de Estudios de Occidente, a Master's Degree (2006) in Social Gerontology from the Universidad de Guadalajara in México, and a Bachelor's Degree in Nursing (1997) from the Universidad Michoacana de San Nicolas de Hidalgo. She is a Professor-Researcher at the Universidad Autónoma de San Luis Potosí, México.

Rosa Eréndira Fosado Quiroz holds a PhD in Chemistry from the Universidad Autónoma Metropolitana – Iztapalapa (2010) and a degree in Chemistry from the Universidad Autónoma del Estado de Hidalgo (1996). She is a Professor–Researcher at the Universidad Autónoma de San Luis Potosí, México.

Ma. del Rocío Rocha Rodríguez holds a Doctorate in Sciences with a specialization in Fundamental Nursing from the Universidade de São Paulo, Brasil. She also holds a Master's degree in Basic Sciences with an emphasis in Experimental Biology from the Universidad de Guanajuato and a specialization in Human Rights from the Universidad de Matehuala. She earned a Bachelor's degree in Nursing from the Universidad Autónoma de San Luis Potosí and a Bachelor's degree in Law from the Universidad Virtual de Guanajuato. She has represented UASLP in the Mexican Council for Nursing Accreditation since 2022 and currently serves as a Professor–Researcher at the Universidad Autónoma de San Luis Potosí, México.

Alejandro Martínez Ramírez holds a Ph.D. degree (2006) and a Master degree (2000) in the Science of Electronics from the Instituto Nacional de Astrofísica, Óptica y Electrónica, México. Bachelor of Electronics (1996) from the Benemérita Universidad Autónoma de Puebla. He is a Professor-Researcher at the Universidad Autónoma de San Luis Potosí, México (E-mail: alejandro.martinez@uaslp.mx).